

Climate Change Trends for Park Planning at President William Jefferson Clinton Birthplace Home National Historic Site, Arkansas

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Historical Trends

From 1901 to 2002, average annual temperature and total annual precipitation increased across North America (Figures 1, 2; Gonzalez et al. 2010). Analyses of causal factors attribute 20th century warming and precipitation changes to greenhouse gas emissions from vehicles, power plants, deforestation, and other human activities (Intergovernmental Panel on Climate Change (IPCC) 2007, Bonfils et al. 2008).

The 50 km x 50 km area that includes President William Jefferson Clinton Birthplace Home National Historic Site (NHS) is part of one of the few areas in the world where temperature has not increased in the 20th century (IPCC 2007). The Southeastern U.S. is an anomalous area (Portmann et al. 2009) where increased precipitation, the El Niño-Southern Oscillation, and other factors have led to a slight, but statistically insignificant decrease in temperature (Figure 3, Table 1). From 1901 to 2002, precipitation increased in the Clinton NHS area, (Figure 4, Table 1), although the trend was not statistically significant.

Future Projections

The Intergovernmental Panel on Climate Change (IPCC) has coordinated research groups to project possible future climates under defined greenhouse gas emissions scenarios (IPCC 2007). The three main IPCC greenhouse gas emissions scenarios are B1 (lower emissions), A1B (medium emissions), and A2 (higher emissions). Actual global emissions are on a path above IPCC emissions scenario A2 (Friedlingstein et al. 2010).

For the three main IPCC emissions scenarios, projected 21st century temperature in the Clinton NHS area could increase 2.6 to 4.4° C (Table 1, Mitchell and Jones 2005, Gonzalez et al. 2010). General circulation models (GCMs) of the atmosphere project decreased precipitation in the Clinton NHS area under all three emissions scenarios, with 10 out of 18 GCMs projecting decreases in precipitation under emissions scenario A2 (Figure 5; historical average from

Mitchell and Jones 2005, Hijmans et al. 2005; projections from IPCC 2007, Tabor and Williams 2010, Conservation International; analysis by P. Gonzalez).

Projections indicate potential changes in the frequency of extreme temperature and precipitation events. Modeling under emissions scenario A2 projects 21 to 28 more days with a maximum temperature $> 35^{\circ}\text{C}$, 12 to 16 more consecutive days with a maximum temperature $> 35^{\circ}\text{C}$, 20 to 25 fewer days with a minimum temperature $< 0^{\circ}\text{C}$, and up to six more days per year of precipitation $< 3\text{ mm}$ (Kunkel et al. in review).

Table 1. Historical and projected climate (mean \pm standard deviation (SD)) trends for the area that includes President William Jefferson Clinton Birthplace Home NHS (Mitchell and Jones 2005, IPCC 2007, Gonzalez et al. 2010). Historical climate and projected climate under IPCC emissions scenarios B1 and A1B are calculated for the 50 x 50 km pixel that includes the park (Gonzalez et al. 2010). Climate under emissions scenario A2 is calculated for the 4 x 4 km pixel that includes the park (data from Conservation International using method of Tabor and Williams (2010)). Note “century⁻¹” is the fractional change per century, so that 0.11 century⁻¹ is an increase of 11% in a century.

	mean	SD	units
Historical (1901-2002)			
temperature annual average	17.4	0.6	°C
temperature linear trend	-0.1	2.0	°C century ⁻¹
precipitation annual average	1300	200	mm y ⁻¹
precipitation linear trend	0.11	0.61	century ⁻¹
Projected (1990-2100)			
IPCC B1 scenario (lower emissions)			
temperature change in annual average	2.6	1.0	°C century ⁻¹
precipitation change in annual average	-0.04	0.07	century ⁻¹
IPCC A1B scenario (medium emissions)			
temperature change in annual average	3.8	1.0	°C century ⁻¹
precipitation change in annual average	-0.05	0.07	century ⁻¹
IPCC A2 scenario (higher emissions)			
temperature change in annual average	4.4	1.0	°C century ⁻¹
precipitation change in annual average	-0.04	0.07	century ⁻¹

Figure 1.

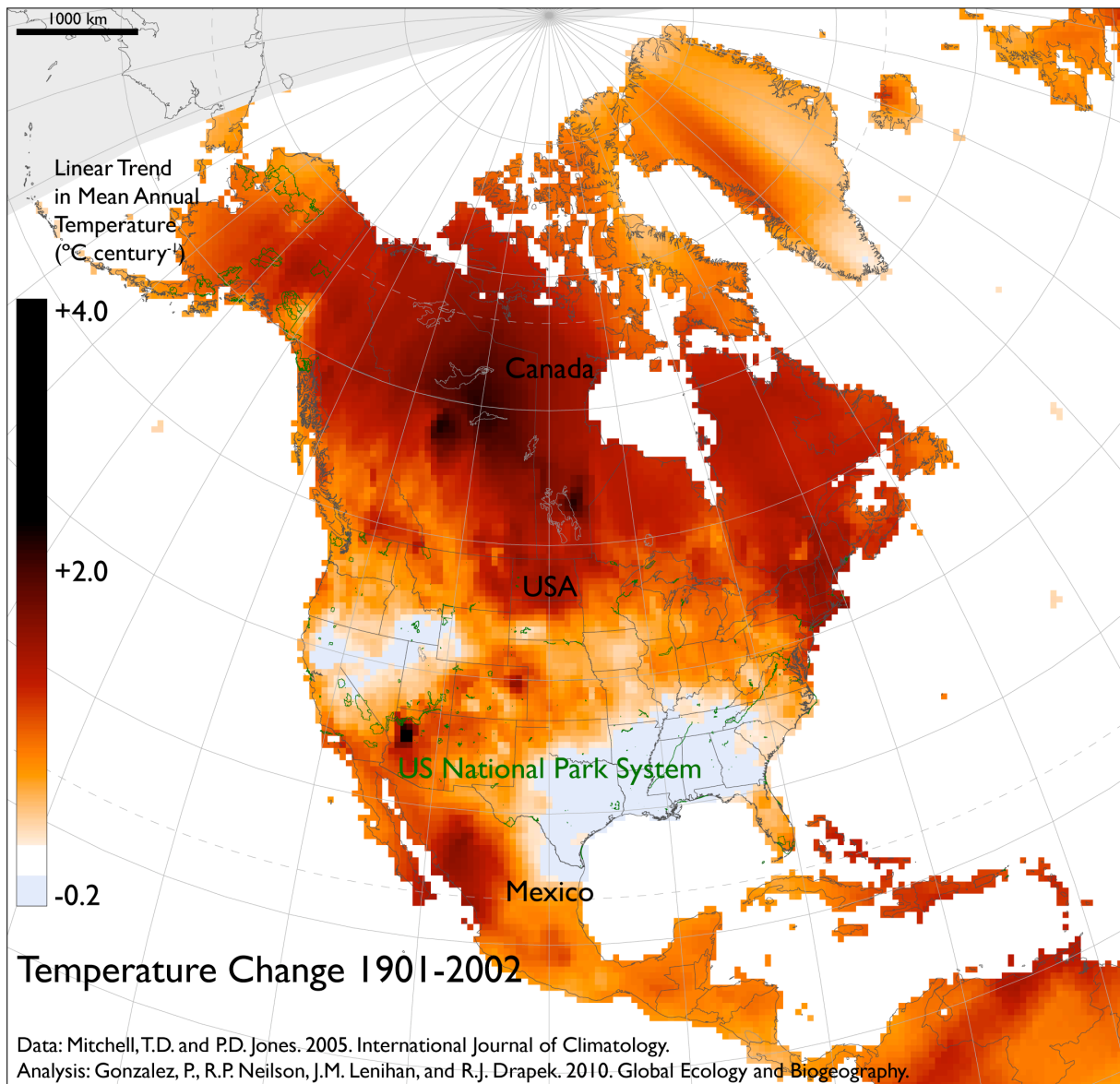


Figure 2.

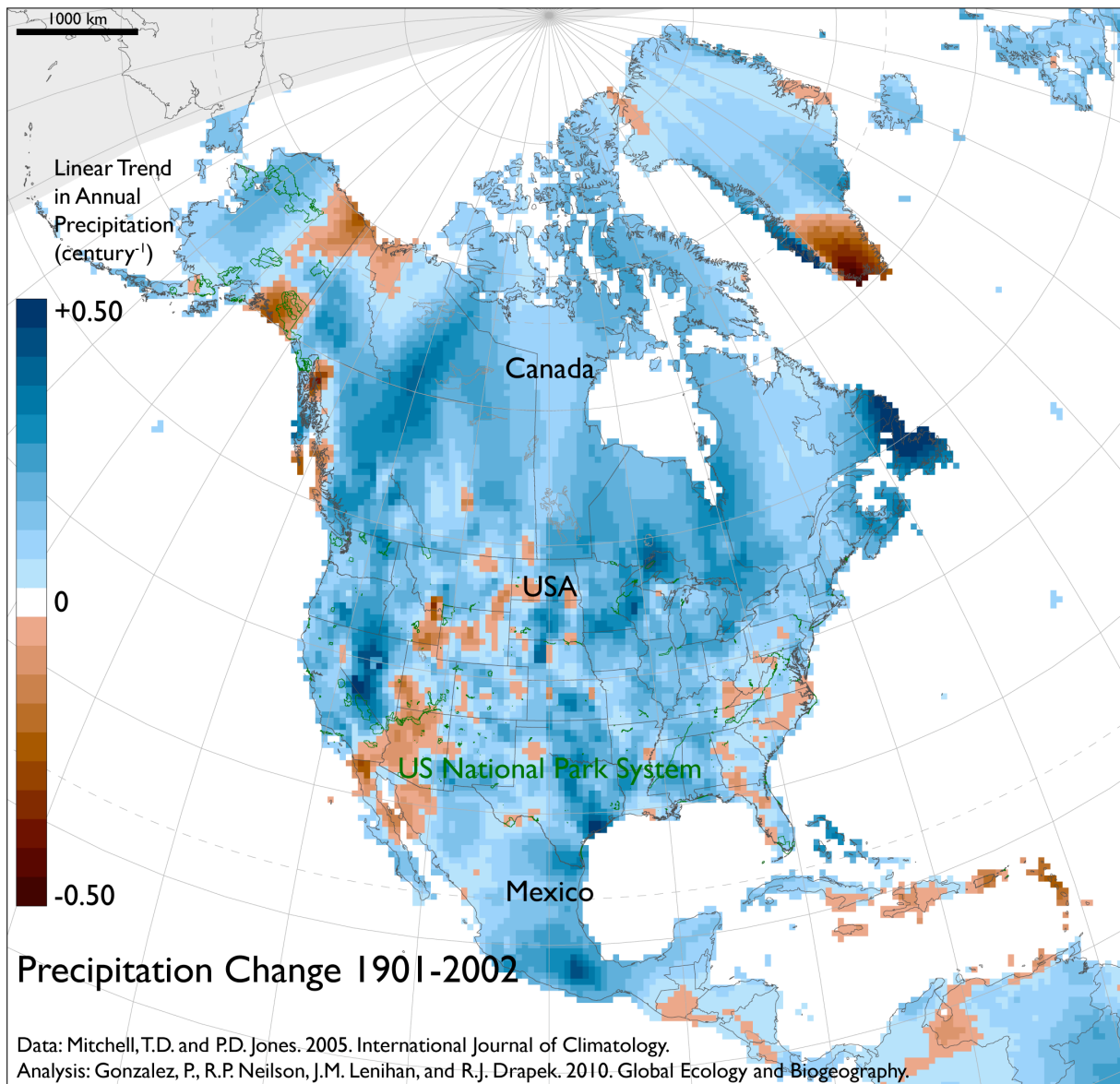


Figure 3.

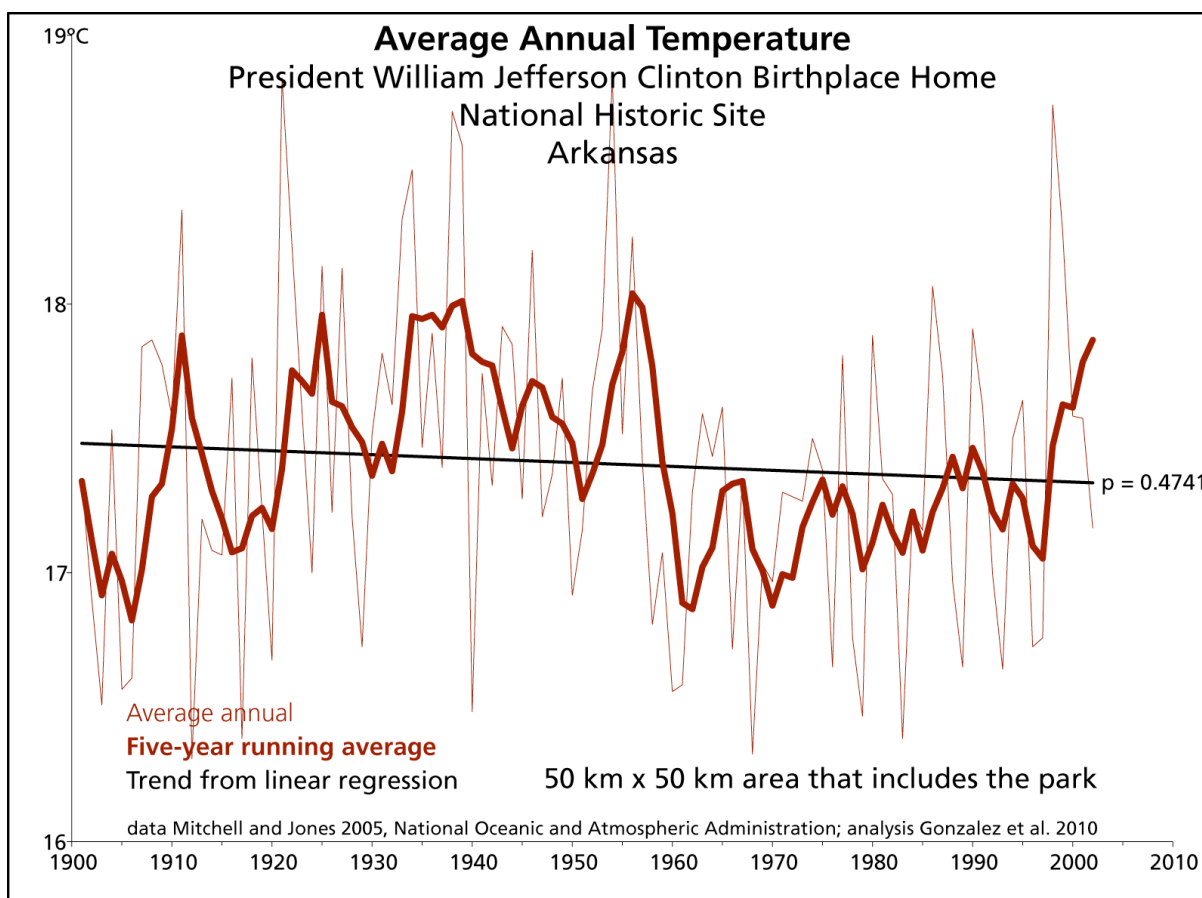


Figure 4.

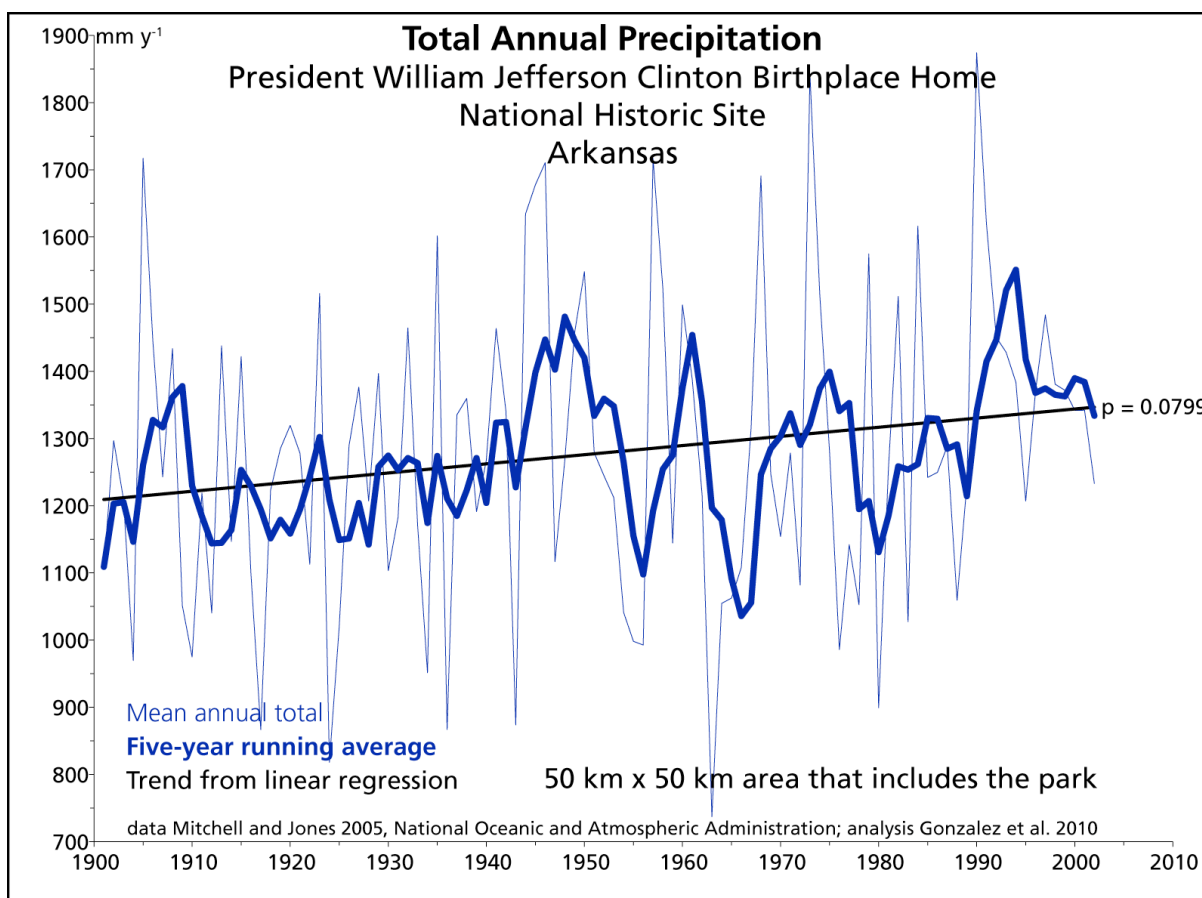
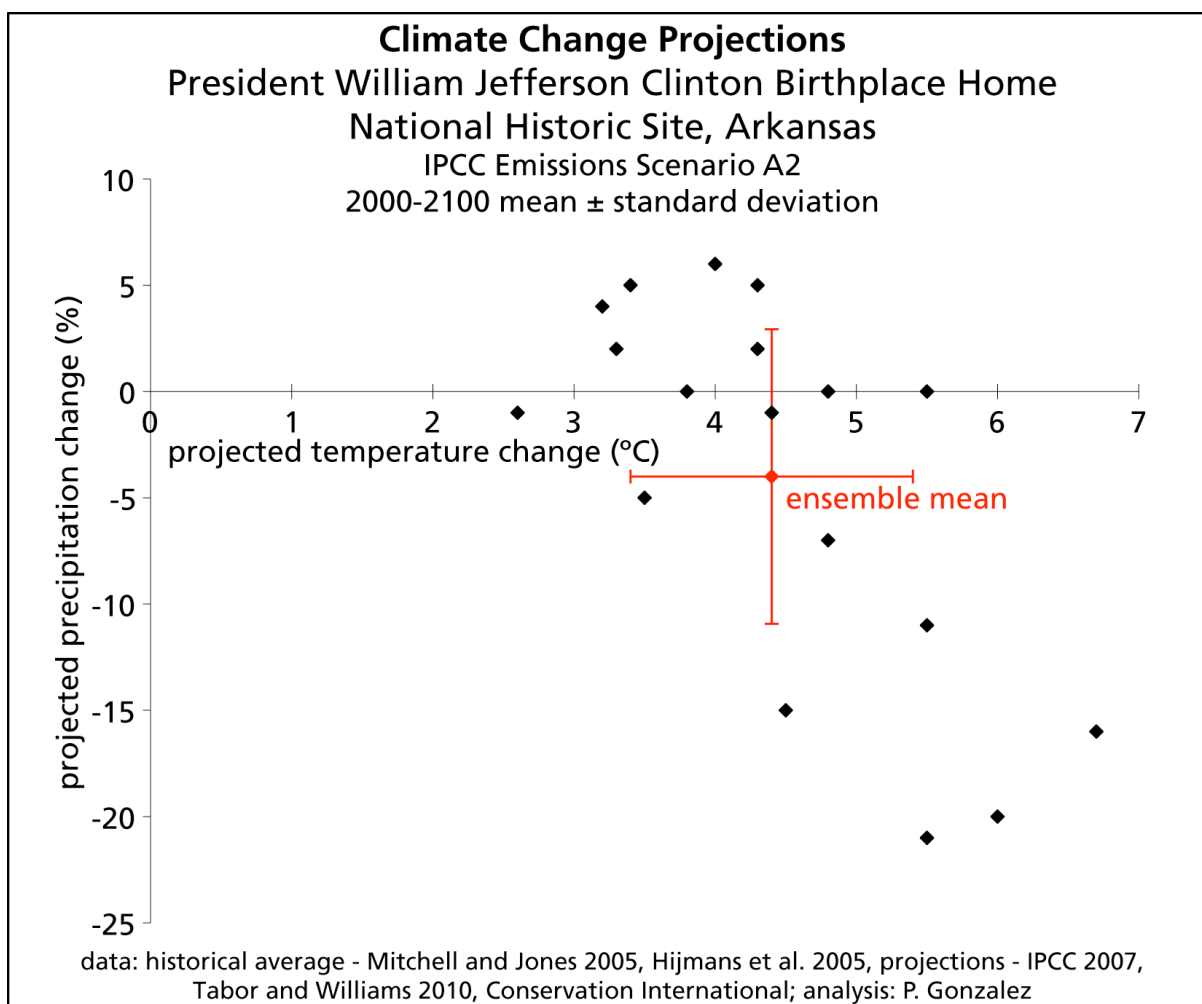


Figure 5.



References

- Bonfils, C., B.D. Santer, D.W. Pierce, H.G. Hidalgo, G. Bala, T. Das, T.P. Barnett, D.R. Cayan, C. Doutriaux, A.W. Wood, A. Mirin, and T. Nozawa. 2008. Detection and attribution of temperature changes in the mountainous western United States. *Journal of Climate* 21: 6404-6424.
- Friedlingstein, P., R.A. Houghton, G. Marland, J. Hackler, T.A. Boden, T.J. Conway, J.G. Canadell, M.R. Raupach, P. Ciais, and C. Le Quéré. 2010. Update on CO₂ emissions. *Nature Geoscience* 3: 811-812.
- Gonzalez, P., R.P. Neilson, J.M. Lenihan, and R.J. Drapek. 2010. Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change. *Global Ecology and Biogeography* 19: 755-768.
- Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones, and A. Jarvis. 2005. Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology* 25: 1965-1978.
- Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007: The Physical Science Basis*. Cambridge University Press, Cambridge, UK.
- Kunkel, K.E., L.E. Stevens, S.E. Stevens, E. Janssen, C.E. Konrad II, C.M. Fuhrmann, B.D. Keim, M.C. Kruk, A. Billot, and M. Shafer. in review. *Climate of the Southeast U.S.* National Climate Assessment. U.S. Global Change Research Program, Washington, DC.
- Mitchell, T.D. and P.D. Jones. 2005. An improved method of constructing a database of monthly climate observations and associated high-resolution grids. *International Journal of Climatology* 25: 693-712.
- Portmann, R.W., S. Solomon, and G.C. Hegerl. 2009. Spatial and seasonal patterns in climate change, temperatures, and precipitation across the United States. *Proceedings of the National Academy of Sciences of the USA* 106: 7324-7329.
- Tabor, K. and J.W. Williams. 2010. Globally downscaled climate projections for assessing the conservation impacts of climate change. *Ecological Applications* 20: 554-565.